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MINING IN CANADA[1]

CANADA covers the northern half of the North American continent, having an area of 3,729,665 square miles. About 700,000 square miles of this great area are covered with rich fertile soil, 900,000 square miles with forest, and 120,000 square miles with lake, etc., while over about 200,000 square miles the surface is buried under a thick blanket of moss. The remainder of the country, as well as some of the forested area, is rocky, and a study of how this rocky country should best be utilized for the benefit of mankind, is one of the greatest research problems of this age, a problem beside which most of those undertaken in our small laboratories dwarfs into insignificance.

The prospector and miner are the men who at the present time are doing most to work out the solution of this problem. In their work they have been assisted for the past eighty years by the Geological Survey of Canada, one of the earliest scientific research bureaus to be established on this Continent, and also, but in later years, by the Geological and Mining Bureaus of the various provinces.

In the 16th century when the gold and silver mines of South America and Mexico were attracting the attention of many of the leading men of the different nations of Europe, Canada did not entirely escape attention, for in 1576, three years after the rich gold mines of Minas Geraes of Brazil had been discovered, Martin Frobisher, one of the great sailors of the "Elizabethan Era," sailed from the Port of London in search of a northwest passage north of the Continent of America to Asia, where fabulous stores of metallic riches were believed to exist. He did not get half way to his destination, but was stopped by ice in a bay on the east side of Baffin Island, whence he returned to England. After his return a

[1] Address of the president and vice-president of Section M, American Association for the Advancement of Science, December, 1922.

piece of black rock which he brought back with him, was drawn to the attention of the "gold finers" of London, who reported that it contained a considerable quantity of gold. In the following year, after receiving direct instructions and encouragement from Queen Elizabeth, he started back with three ships to look for more of this gold, having several "gold finers" with him. His ships were not of the class that we are accustomed to think of as crossing the Atlantic at the present day, for while one was of 180 tons, the other two were of about 30 tons each. After arriving at their destination, since known as Frobisher Bay, they labored hard for twenty days and loaded 200 tons of "ore," which they took back with them to England. Most of this "ore" was stored in Bristol Castle and the rest in the Tower of London. Samples were given out from time to time, but the returns on these samples seem to have been very contradictory. One assayer, who had been with Frobisher, and who had directed the "mining," claimed that if properly "treated and coaxed" it would yield £40 to the ton, while most of the goldsmiths of London said that they could not find any gold in it at all. Nevertheless many of the people interested in the expedition believed firmly in the richness of this reported gold discovery, the Queen being among the number. Accordingly it was decided to follow up the last expedition with a very much larger one, and for this purpose a fleet of fifteen ships was got in readiness. These took along not only the necessary crews to sail the ships and collect the ore, but a hundred men to form a settlement and remain at Frobisher's Bay for a year. The fleet sailed in May, 1578, and arrived at its destination about the 1st of August, though one ship sank on the way. Capt. Best of the "Ann Francis," one of the ships of the fleet, discovered "a great black island with plenty of black ore on it." The work of loading some of the ships went on through the month of August. While the "ore" was being mined and loaded, the masons and carpenters who had been brought from England to erect a fort, built a small stone house and within the house, they built an oven and placed some baked bread in it in order to show the Eskimos, who occupied the country, how to build a house and what to do in it when it was built. On the last day of August, all set sail for England, where they arrived about the 1st of October, but what became of the so-called ore is not known. Certainly the Company of Cathay, under whose name the enterprise was undertaken, met with financial disaster.

The scene of Frobisher's mining operations was unvisited for nearly three centuries, and it remained for Capt. C. F. Hall in 1861 and 62, while exploring in Frobisher's Bay, to rediscover all that was left of Frobisher's stone house and the pits dug by his men in their mining operations.

It might be an interesting trip for some of the many owners of yachts on the eastern coast of America to go to Frobisher's Bay and revisit the site of this mining stampede of three centuries and a half ago. It is possible that the black rocks referred to by these old sailors may have belonged to the Keewatin or Pre-Cambrian series which is yielding such large quantities of gold in Porcupine at the present time.

The next record that we have which would indicate any interest in the mineral wealth of Canada was in 1609 when Master Simon, a French mining engineer who accompanied a military expedition under De Mont, discovered native copper at Cape Doré on the east coast of Nova Scotia.

In 1672 Denys mentions coal seams near Sydney, Cape Breton, this being the first record of coal on the Continent of America. From that time onwards coal has been mined more or less continuously from these seams. In 1711, a British naval expedition sent to attack Quebec obtained coal from these seams where they outcrop in the cliffs, and later in 1720, systematic coal mining was begun by the French to supply the men building the fortress at Louisburg, and those living in the colony at Halifax, the amount usually raised for this purpose being from two to three thousand tons a year. The coal mining industry in Nova Scotia has gone on apace since then, the annual production at the beginning of this century being 3,300,000 tons, and for 1920 it was 6,429,200 tons.

Going farther west into the Province of Quebec, the early settlers recognized the existence

of bog iron ore about the middle of the 17th century.

In 1686, Chevalier De Troyes, accompanied by D'Iberville and his two brothers, the heroes of many battles with the British, started in March from Montreal through snow-covered woods and over ice-bound rivers, with a party of one hundred armed men to attack, and if possible to destroy, the fur trading posts belonging to the Hudson's Bay Company on the shore of Hudson Bay. They traveled westward up the Ottawa River and then northward across Lake Timiskaming. While on this lake, they visited a lead mine, on its east shore, just opposite and only twelve miles away from the rich silver mines at Cobalt. Dr. Miller, of the Ontario Bureau of Mines, in one of his papers on the Cobalt District, has asked the question, "What would have happened if these Frenchmen had discovered the rich native silver ores of Cobalt, which would have competed in richness with the greatest of the silver ores of Mexico or Peru?" The question was of course unanswered.

In the beginning of the 18th Century the few white men who were in charge of the fur trading establishments of the Hudson's Bay Company, on the shore of Hudson Bay, became excited over stories brought in by Indians of great quantities of native copper which could be picked off the ground on the banks of a river away to the north, and in 1719 Captains Knight and Barlow sailed in two ships, well provided with provisions, and also with strong iron-bound boxes in which to bring back precious metals, for the north west point of Hudson Bay. They were wrecked on Marble Island and all were lost.

Three years later Captain Scroggs took another expedition up the west shore of Hudson's Bay, and Richard Norton, who was in charge of the trading post at Churchill, continued the search by land for many years.

In 1769, fifty years after Knight's ill-fated expedition, Samuel Hearne was sent inland from Churchill on foot with a band of Indians to find the great deposit of copper on the bank of the distant river. He reached the Coppermine River near its discharge into the Arctic Ocean, and verified the existence of native copper in its vicinity, but at the same time he showed that the quantity obtainable was too small to be of commercial importance.

In 1737 iron furnaces were built at St. Maurice in the Province of Quebec to smelt the bog iron ore of the vicinity. They supplied the people of Quebec with their iron for many years, and in fact have been in blast almost down to the present time.

In the Province of Ontario, the first iron furnace was built in 1810, in the County of Leeds, and the next one in 1813 at Normandale in Norfolk County near the shore of Lake Erie. This furnace remained in blast down to 1847, using bog iron ore and charcoal and producing about three tons of iron a day. The iron was used in the foundries throughout that portion of Canada for the manufacture of stoves and all ordinary iron articles.

Gold was first discovered in the gravels of the Chaudiere River and its tributaries in the Province of Quebec about 1823 or 1824, and from that time onwards some gold was recovered every year, the most active operations having been undertaken between 1860 and 1875. Altogether about $3,000,000 worth of gold has been extracted to date by mining operation from these gravels.

In 1859 or 1860 some of the pilgrims crossing the plains from the Red River Country, either from what is now the Province of Manitoba, or from the State of Minnesota, discovered gold in the sands of the Saskatchewan River, and from then until now, the sands of that river have reguarly yielded a little gold to the placer miners. In some years the yield was as much as $50,000 and in other years very much less. Altogether the river is believed to have yielded more than $600,000 worth of gold.

In British Columbia gold was discovered in 1852 in gravel at Gold Harbor on the west coast of Queen Charlotte Island, though very little mining was done. In 1857, it was discovered on the Fraser River, and in the following year a great stampede set in from California, and the country to the south, to these new diggings. Prospectors pushed up Fraser River from bar to bar, and then back through the country until, in the winter of 1860-61, they crossed over to Williams Creek and discovered the rich placers of Cariboo.

About this time the precious metal was dis-

covered in quartz veins in Nova Scotia. These veins which occur in folded Pre-Cambrian rocks have been producing gold from that time up to the present, the total yield to date being about $18,000,000.

Six years later gold was discovered in Hastings County in the Province of Ontario. The men who made the discovery knew so little about the metal that they would not believe that it was gold until they had the word of a member of the Geological Survey of Canada.

In 1868 silver was discovered by the Montreal Mining Co. at Silver Islet, on a little rocky island, less than an acre in extent, near the north shore of Lake Superior. During the next few years this mine yielded more than $3,000,000. In the vicinity of Silver Islet on the shore of the lake, silver had already been known to exist, and some small mines in that vicinity have yielded a little ore, but none of them have been sufficiently productive to add materially to the wealth of the country. After the ore at Silver Islet was exhausted, silver mining remained quiescent in Eastern Canada until the rich deposits at Cobalt were discovered in 1903.

Copper had been known to exist on the shores of Lake Superior for a century or more, but the valuable ore bodies all seem to be collected on the American side of the lake rather than in Canada. In 1847, copper ore was found at Bruce Mines on the north shore of Lake Huron, and mining was carried on there for many years with varying success.

In the decade following 1858, copper mining was prosecuted energetically and often successfully in the eastern townships of the Province of Quebec, and at one of the mines a shaft was sunk to a depth of 3,000 feet.

In 1847, the occurrence of asbestos was made known by the geologists of the Geological Survey of Canada in the southern portion of Quebec and thirty years later active mining and milling of the ore began. This industry has now developed into the largest mining industry in Quebec and provides most of the asbestos used in the world.

Such was the condition of mining in Canada in the year 1885, when the Canadian Pacific Railway was opened throughout its length from the Atlantic to the Pacific. At that time the country had a population of five million three hundred thousand people, almost entirely engaged in agricultural pursuits or in developing the immediate products of agriculture. The early settlers, both French and British, were agriculturists and had settled on the rich farming land near navigable waters, whether of the Atlantic Ocean or of the Great Lakes, for the waterways formed the main lines of transportation through the country. There were vast areas of similar rich land in the wilderness back from the water, but it could not be easily reached and little was known about it. Highways and railways were afterwards built through or near the parts of the country that had thus been settled, but the people did not begin to move into the great interior regions of Canada until about 1885, when the northern parts of the Province of Ontario, and the Provinces of Manitoba, Saskatchewan, Alberta and British Columbia were rendered accessible by the building of the C. P. R. from Montreal to Vancouver. Up to that time in spite of the many discoveries of minerals and ores of various kinds which had been made at widely scattered localities throughout the Dominion, the actual production was still very small. In 1886, the first year in which an accurate statistical report on mineral production was compiled and issued, the total output of useful minerals of all kinds, metallic and non-metallic, had a value of only $10,220,000 or $2.23 to the head of population.

A new mining era had however begun to dawn for us. The building of the C. P. R. provided means of access to a previously inaccessible country. New districts were opened up. In a rock cutting on the right-of-way of this new railway itself was exposed for the first time one of the deposits of nickel ore near Sudbury, Ontario, where the greatest nickel mines of the world are now situated.

About that time systematic geological exploration of the Rocky Mountains was begun by Dr. G. M. Dawson, one of the geologists on the Geological Survey of Canada, and with him I had the pleasure of being associated as assistant. We explored from the International Boundary northward to the Bow river, and during the summer of 1883 we determined the existence of the great coal seams in the Crow's

Nest Pass. I remember very well, a hot day on the 12th of July, when camped on the banks of Mitchell creek, on land which I believe is now owned by the Crow's Nest Pass Coal Company, we divided our energies, he going up stream and I down, and my gratification at finding the outcrop of a beautiful seam of coal three feet in thickness.

Farther west in British Columbia the great silver-lead mines of East and West Kootenay and Slocan districts were discovered and active development was begun on many of them.

As a consequence of this increased interest in mining, the mineral production rose in four years to \$16,763,000 or \$3.50 to each head of population.

During the next five years discoveries and development were continued with unabated enthusiasm, and production increased steadily, so that by 1895 the value of our mineral products had reached \$20,500,000, or \$4.05 per head, having doubled in less than a decade.

The following year the rich gold placers of the Klondike were discovered, and by 1900 the output of all our mines had increased to a value of \$64,400,000 or \$12 per head of population. In five years the value of the mineral production had more than trebled. Half of this increase, or a third of the total production, was derived from the rich placer mines of the Klondike, where the value of the output for 1900 was \$22,275,000, but the other half of the increase was due to the general interest which the people were taking in mines and to a consequent general increase in the mineral output of the whole country. For instance the output of the mines of Nova Scotia increased \$4,500,000, due chiefly to the increase in output of coal, and of British Columbia \$10,700,000 made up of gold, silver, copper, lead and coal.

After 1900 the production of gold from the placers of the Klondike quickly declined, and by 1905 it had dropped from \$22,275,000 to \$7,875,000, but notwithstanding the heavy decrease in the production of that very interesting old camp just south of the Arctic Circle, where I myself spent seven years of my life, mining had been so successfully prosecuted throughout the Dominion that the general mineral production, instead of declining, had increased to a value of \$69,000,000. This increase was divided among the various provinces as follows:

Nova Scotia, \$2,200,000, chiefly coal; Quebec, \$1,100,000; Ontario, \$7,600,000; Manitoba, Saskatchewan, and Alberta, \$3,500,000; and British Columbia, \$5,700,000.

Towards the close of this half decade a new silver field was found among the pine forests of Northern Ontario by some of the men who were working on the construction of the new T. & N. O. Ry. The influence of the find was just beginning to be felt and in 1905 it accounted for about \$1,400,000 of Ontario's increase. The center of this silver district is now the town of Cobalt, and up to the end of December, 1921, it had produced 323,324,000 ounces of silver, valued at \$198,170,000, and its mining companies had paid \$92,283,820 in dividends to their stockholders. Considering the great richness of its veins, the ore in a number of places running as high as 10,000 ozs. to the ton, and its small area, the district is one of the richest of the great silver-bearing areas of the world.

In 1910, our mineral production had increased from a value of \$69,000,000 in 1905 to \$106,800,000. \$14,000,000 of this increase was due to the output of silver from Cobalt, while \$23,000,000 was due to the general increase in mining throughout the whole of Canada. In the provinces other than Ontario, the increases were as follows: Nova Scotia, \$2,700,000; Quebec, \$3,800,000; Alberta, chiefly coal, \$7,000,000; British Columbia, \$2,100,000. At the end of this period the Porcupine gold district in Northern Ontario had been discovered, but production had scarcely begun.

In 1915 our mineral production had increased to a value of \$137,000,000, with a per capita value of \$17.30, the greatest increase being in the Province of Ontario, which had raised its output from \$43,000,000 to \$61,000,000, the items chiefly responsible for this increase being gold and nickel. Nova Scotia, Quebec and British Columbia also showed substantial increases in spite of the fact that some of the metals, etc., had had a substantial drop in value during the first years of the Great War. The value of the total metallic production in this year was \$75,800,000, the principal items of which were nickel, gold, copper and silver in

the order here given, while the non-metallics had a value of $61,200,000, of which coal accounted for two thirds.

In the five year period ending in 1920, the value of our mineral production almost doubled, being in this latter year about $228,000,000, but in this instance the increase was largely in the non-metallic products, coal alone having increased in the value of output from $32,000,000 to $80,000,000. In Nova Scotia the increase was from $18,000,000 to $34,000,000 due to coal, in Quebec from $11,600,000 to $28,800,000, chiefly due to asbestos, in Ontario from $61,000,000 to $81,800,000, Alberta $9,900,000 to $33,600,000 due to coal, British Columbia, $28,700,000 to $39,400,000, its chief products being coal, copper, silver, zinc, lead and gold in the order named. Taking the whole Dominion the chief mineral products were now in order of value, coal, nickel, gold, asbestos, copper and silver.

A feature of this half decade was the great development of coal mining in Alberta, which in 1920 led all the other provinces of the Dominion.

However, the most spectacular characteristic of the decade from 1910 to 1920 was the development of the great gold mines of Porcupine and Kirkland Lake in Northern Ontario. The first gold production was in 1910, amounting to 3,089 ozs. of a value of $62,849. In 1915 it had risen to 406,577 ozs. with a value of $8,404,693. For the next three years both development and production were greatly retarded on account of the scarcity of labor, for most of the friendly miners had joined the army and were fighting for the Allies, while the mechanics that were not in the army were in munition factories. By 1920, however, labor had become more plentiful and more efficient, and production was again on the increase. In that year Porcupine and Kirkland Lake produced gold to the value of $11,686,043. In 1921 this had increased to $14,624,085, and during the year just past it will doubtless reach $21,000,000, which will place it far in advance of California, or any of the other States of the Union. For the whole of Canada the gold production for the past year will probably reach a total of $27,000,000, which will place it easily third among the gold producing countries of the world, being only exceeded by Africa and the United States.

The development of the mineral resources of the country has depended on transportation. We have seen that it had scarcely begun until the C. P. R. was built across the continent. This gigantic railway enterprise cost $680,000,000, and now our mineral production alone is rapidly reimbursing us for the great expenditure, and of course the increase in the agricultural production of the country is many times that of its mineral production.

Thus you see that although there have been spectacular discoveries of great mineral wealth in Canada at various times, and in various places, such as in Cariboo, Klondike and Cobalt, and although these fields have all declined in production, nevertheless other discoveries, perhaps not so spectacular, were made, and new mining fields were opened so that every fifth year there has been an increase of production over the previous fifth year, and that in 34 years the production has increased more rapidly than in any other country in the world, except possibly South Africa. Canadians are naturally proud of this record, even though the credit may rest much more largely with the country than with themselves.

I have presented these figures as evidence of Canada's steady and uninterrupted growth in mineral, production, but nevertheless it must be remembered that her population is yet very small, less than three to the square mile, and almost all of these are distributed near its southern border. Most of the knowledge of the mineral and other resources of the country has been acquired by the people who live in this southern border belt, and the greater part of such knowledge refers to the country immediately contiguous to, or at least at no great distance from, this belt.

Thus though Canada has developed into an important mining country, its mines are all situated in, or not far beyond the confines of, this southern border belt, and the vast country beyond is yielding practically nothing. Among the producing mines are the great nickel-copper mines of Sudbury, the chief source of the nickel supply of the world; the silver mines of Cobalt, perhaps the richest silver-bearing area of the world; the gold mines of Porcupine,

which comprise three of the greatest gold mines of the world, together with important mica, feldspar, and talc mines, all in the Province of Ontario; the asbestos mines of Quebec, the source of most of the asbestos of the world; the coal mines of Nova Scotia and Alberta, and the coal, copper, lead and gold mines of British Columbia. There are doubtless many mines yet to be discovered in the southern border belt, in the vicinity of those already known and in active operation, but farther north is a vast area which is still unoccupied and the mineral resources of which are yet undiscovered. The means of transportation into it are slow and imperfect, and no dependable local supplies of food are available, so that even when men penetrate into it, as they can do in canoes, they are unable to live and work there until they can obtain a regular supply of provisions from the settled country to the south. But, as you know, transportation facilities are being improved all the time. With these improvements the frontiersmen who are accustomed to live on the borders of civilization, and to start the development of a country, continue to push farther into the wilderness. They make the first discoveries where the exposures of minerals are most conspicuous, but after having made these they push farther into the wilderness and leave development to those who come forward from the larger centers of population. The three processes of discovery, development and production keep going on at the same time in different parts of the country, and as long as we have new country to explore we may be reasonably certain that new discoveries will be made and that production will increase.

The mere fact that a country has been travelled over for years by fur traders and foresters, and that mineral wealth has not yet been discovered in it is little or no indication that such wealth is not present in its rocks. Cobalt was in the middle of one of the finest white pine areas of Northern Canada, and the lumbermen had been working in it for a long time before the contractors and laborers on the T. & N. O. Ry. discovered silver in it; and the Hollinger Mine, one of the great gold mines in the Porcupine district in Northern Ontario, was right on a portage which had been used by fur traders for a century or more, and when the gold-bearing quartz veins which are now yielding gold so abundantly were discovered by the prospectors, they had already been polished by the moccasins of the traders and packers as they carried their furs down to Moose Factory on Hudson Bay, thence to be shipped to London.

At the present time our country offers a field for extensive and intensive research second to none in the world. One of the main objects of that research should be the finding of bodies of ore which could be economically developed and utilized for the benefit of mankind. There is no finer laboratory anywhere than the one in which this research must be conducted, for it was constructed by the Great Architect of the Universe himself, it is almost limitless in size, in variety of problems to be solved, and in the facilities for solving them.

Up to the present time most of the known mineral deposits of the country have been accidentally discovered by hunters, casual wanderers through the wilderness, or prospectors who have had very little training except in the school of hard knocks, although it must not be forgotten that our Scientific Departments, such as the Geological Survey of Canada, and the Geological and Mining Bureaus of the various provinces, have often pointed the way to the areas where rocks and structural conditions are the most favorable for the occurrence of ore, and where, consequently, exploration might be undertaken with the greatest likelihood of success. I hesitate even to hazard a guess as to how far our mining industry would be behind its present stage of development, were it not for the assistance given it by these departments.

But if most of the prospectors and discoverers have not been trained in colleges and universities, most of the men who have taken charge of the development of the mines after they were discovered have been college men, and the success achieved by them has doubtless been in no small measure due to their college training. The need of scientific training for mining engineers, and for all those in any way connected with the production of our mineral wealth, is increasing every day, for their work is becoming vastly more complex and difficult.

Some college trained engineers who desire or need a life in the great outdoors will use their training and knowledge in the discovery of ore bodies, where untrained men would not be likely to find them, or would pass them by. Other trained engineers will explore these ore bodies and if found to be sufficiently rich or large, will pass them on again to others, who will develop them into producing and paying mines.

Your universities as well as ours can assist in the development of Canada by giving a thorough training in mining and geology, with all the collaterals that these sciences imply, to all three classes of engineers mentioned above, and also to directors or prospective directors of mining companies so that they also may understand and appreciate the work done by their several engineers. With such assistance the Canadian Mining industry would increase and develop at an even more rapid rate than it has done in the past.

J. B. TYRRELL

THE SCIENTIFIC RESOURCES OF FRANCE

To those who harbor an impulse which keeps them, throughout life, arduously laboring in scientific fields, the great cultural institutions of France appeal with peculiar power. Some of my French friends remark, "Yes, the Frenchman invents, creates and embellishes and then ceases to interest himself in the creatures of his mind." A surgeon whose name is internationally honored said, when the purpose of this paper was explained and his aid sought in the collection of material, "C'est très important! En France, nous créons des grandes organisations, et après, nous nous en moquons trop!" In a sense it may be true that the intellectual wines of Europe need no bush, yet descriptions of the educational resources of the Old World never fail to be eagerly scanned by the American scientific public and what may be termed our general student body. Novel light on the ancient beaten paths which all students must tread, pointing again the rough, unroyal highway in which the world's best workers have bruised their hearts and cudgelled their brains, seems ever welcome. It reminds present pilgrims of the beautiful democracy of ideas, or aristocracy of ideas, if you will, which has placed marvelous forces within reach of every human mind which would seek to employ and direct them. And, besides an undertaking for my own countrymen, the present paper constitutes a labor of love and humble tribute devoted to the genius of France. Probably there have never been as many American students in attendance at French institutions as now. There is every indication that their number will be continually swelled. The old wells of knowledge still flow and the strata of fact ever accumulate in the world's huge centers. The flood of inquiring spirits surges about the doors of hoary institutions and threatens to submerge and block their portals, yet is somehow sluiced away, leaving ample room for perpetually rising tides.

The undergraduate institutions, such as the Sorbonne, University of Paris, and provincial universities like those of Lille, Lyon, Strasbourg, Bordeaux, Montpellier, Grenoble and many others possess libraries, laboratories and museums which may be utilized by postgraduate students. In fact, the special student may find that his particular needs will require a visit to one or more of the schools outside Paris. For French students living far from Paris the local university and its attributes are highly important. The foreign student naturally first interests himself in Paris.

At Paris, the Institut de France, Académie de Médecine, Collège de France, Institut National Agronomique, Académie d'Agriculture, Institut Pasteur and, especially, the libraries, are supremely interesting. In addition, the Observatories, Radium Institute, various museums, the Polytechnic School, Institute of the Arts et Métiers and other special colleges, laboratories and manifold sources of information are available to the special worker.

All these organizations are separate and independent. Sometimes a loosely common tie is constituted by direction by the same ministry, such as that of the Public Instruction, Agriculture, etc. However, the faculties, officers and members are not officially inter-related. The institutions have originated differently and developed, each by itself, through centuries of changing and often troublous history. In a

paper of this kind, scarcely more than mere mention can be made of the very numerous educational resources centering in Paris alone. However, something of a sketch will be attempted. And, in this endeavor, the institut has been selected, first, because it constitutes the summit of French intellectual achievement and second, because it is a type generally representing the learned bodies of France. It is here concerned mainly on account of a single one of its five constituent Academies, the Académie des Sciences. In justice to the institut, this state monument of surpassing interest to all liberal minds, a review is indispensable. The principal chronology may be tabulated in the following scheme:

1635. Richelieu interests himself in an existing literary society, whose meetings are held with one of the members, Conrart. Becoming the protector of this society, Richelieu lays the foundation for the future Académie Française.

1648-71. Royal Academy of painting and sculpture, and Royal Academy of architecture, aided by Mazarin and Colbert.

1663. Royal Academy of Inscriptions et Belles Lettres organized by Colbert.

1666. First meeting, December 22, of the Royal Académie des Sciences.

1793. Suppression of all intellectual organizations by the revolutionary National Convention.

1795. True birthday and foundation of the Institut, October 25 (Brumaire 3, Year IV), under the title "Institut National des Sciences et des Arts." The new Institut was not related to the preexisting Academies, except in so far as the fact that some of their members became members of the Institut. The Institut was composed of three classes, namely, of the physical and mathematical sciences, moral and political sciences, and French literature and fine arts.

1803. Reorganization by Napoleon's Consular Decree of January 23 (Pluviôse 3, Year XI), with abrogation of the class of moral and political sciences and formation of the four classes of the physical and mathematical sciences, French literature and language, ancient history and literature, and fine arts.

1816. Interesting principally because the term "Académies" was substituted for that of "Classes."

1832. Royal decree restoring the class (called Académie) of moral and political sciences.

This skeletonic calendar suggests the present composition of the Institut. The latter is autonomous, consists of five Academies and is maintained by funds provided by the French government and bestowed by private individuals. In the order of their usual ranking, the constituent Academies are the Académie Française, Académie des Inscriptions et Belles Lettres, Académie des Sciences, Académie des Beaux Arts and Académie des Sciences Morales et Politiques. The president of one of the academies automatically rotates to the presidency of the Institut. Each academy is represented in the presidency of the Institut for a year. The chief of the Académie Française, the only officer styled "Director," is elected every three months, presidents of the four other academies being elected annually. Accordingly, in years when the presidency of the Institut is represented by the Académie Française, the Institut has four presidents, each serving for three months. This condition chances to exist in 1922, the present president of the Institut being Monsieur Henri Regnier, director of the Académie Française. The secretary is Monsieur Frédéric Masson.

The secretaries of the academies are perpetual and elected for life. They constitute the real directors, since they thus remain in contact with permanent policies. In association with two members delegated to the central administrative committee described further on, they administer the academies' finances. They also designate the programs of the weekly meetings and supervise publications. Perpetual secretaries are practically always great savants. Among those who have so served are Joseph Bertrand, Darboux, Cuvier, Arago and Pasteur. After becoming ill and unable to continue active secretarial duty, Pasteur was made perpetual honorary secretary in the Académie des Sciences.

As shown by the chronological table, the Institut dates from 1795. Before this date, the various academies, which had been created and developed under Louis XIII and Louis XIV, were entirely separate and independent. Liberal thought had begun to flourish actively by the time when its exaggerations, combined with France's difficulties, had precipitated the Revolution. The dominant spirit in the Na-

tional Convention feared free thought and opposed it. Saron, Bailly and Lavoisier were guillotined, while Condorcet preferred suicide. These men were destroyed because of their political activities and, so to speak, in spite of, and not by reason of, their scientific accomplishments. The royal decree of 1832 fully restored all the elements suppressed by Napoleon and launched the Institut on a course which has been practically uninterrupted since that time.

The governmental funds allotted to the Institut are apportioned as follows:

Académie Française	150,000 francs
des Inscriptions et Belles Lettres	79,000
des Sciences	175,600
des Beaux Arts	97,400
des Sciences Morales et Politiques	87,400
Library	15,600
General	81,400
Total	688,400

Obviously, the library fund is utterly insufficient. At the present rate of exchange, it is equivalent to about $1,500, or to about $3,000 only, were exchange at the prewar rate. The library is cyclopedic, containing valuable works on all the subjects in which the several academies are interested. On account of the paucity of this library fund, and especially in view of the fact that the government will be unable to supplement it for a long time because of the grave post-war financial conditions, the Library of the Institut would be most grateful could it receive, free, the important bulletins and other valuable publications issued by the United States government and by the several states. An appeal of this kind is hereby made to the federal bureaus and to the numerous educational, scientific and other liberal agencies existing in all our states. National, state, university and other publications may be sent to the Conservateur de la Bibliothèque de l'Institut, 23 Quai de Conti, Paris. Perhaps in no way can our country so effectively aid the country which so materially secured to us our victory in the days when our independence was darkly and gravely uncertain. With us, it must be remembered that the question of this sort of assistance is scarcely one of material cost, for free publications by the bushel, of which one copy each would be gratefully cherished by the Institut library, are unceremoniously dumped into American wastebaskets.

The Institut administers various foundations and awards many prizes. Of the government funds, only 22,000 francs are devoted to prizes. The funds of the several academies, and the general and library funds of the Institut, are administered by a committee, the Commission Administrative Centrale, composed of the perpetual secretaries and two members delegated by each academy. Excepting secretaries, each member of the Institut receives 1,200 francs annually. Secretaries receive 8,000 francs.

It must be remembered that the foundations bestowed upon the Institut must be administered according to the specifications of the donors. These specifications are usually precise, thus largely leaving the Institut powerless to convert the funds otherwise, even in the presence of great emergency, such as that confronting the library. Of these foundations, perhaps the most generally useful is the Jean Debrousse Foundation of 1900, consisting of a million francs. From this foundation, various sums are expended in the aid of scientific, historical and other works, and for the maintenance of publications. The Montyon prizes are very important. The most important single prize, the Osiris, of 100,000 francs, is awarded triennially for outstanding contributions to science, letters, art, industry or general public welfare. Roux, who was director of the Pasteur Institute when awarded this prize in 1903, immediately bestowed it upon the Institut Pasteur.

Various museums, chateaux, estates, etc., have been bestowed upon the Institut and constitute important research resources, largely in the fields of history and literature. Among these are the domain of Chantilly (Museum Condé), given by the Duc d'Aumale; the estate at Chaalis and the Museum Jacquemart-André, in the boulevard Haussmann, at Paris, bestowed by Madame Jacquemart-André; the Chateau de Langeais and Hotel de Thiers, at Paris; and the Abbadia Observatory of the Académie des Sciences, situated at Hendaye, on the Spanish frontier near Biarritz.

The library of the Institut, partially discussed above, is private, situated on the premises of the Institut at 23 Quai de Conti, and open on Mondays, Thursdays, Fridays and Saturdays, from noon to 6 P.M. Workers must be introduced by members of the Institut. The Mazarin library (Bibliothèque Mazarine) is also quartered on the site of the Institut. It is public, and chiefly devoted to history and literature. It is quite independent of the Institut library.

The creator of the Académie des Sciences was Colbert, controller of finance under Louis XIV. Among its members have been Lavoisier, Condorcet, Buffon, Lagrange, Laplace, Biot, Ampère, Fresnel, Lamarck, Becquerel, Dupuytren and Magendie. Some of the distinguished perpetual secretaries have been already named. Bonaparte was elected a member in 1797.

The membership comprises a total of 218, of whom two are the perpetual secretaries. The classes of members are titular, or regular (68), free (10), non-resident (6), corresponding (116), foreign associate (12) and include 6 members from the new section on the Application of Science to Industry. Free members are not necessarily great savants, but may be chosen on account of their scientific interests and general relations. They receive no compensation and have no vote in elections. Corresponding members may vary in number and represent various regions of France, the French colonies and foreign countries. Foreign associates are always scientists of the first order.

The members are distributed among 12 working sections, namely, of Geometry, Mechanics, Astronomy, Geography and Navigation, General Physics, Chemistry, Mineralogy, Botany, Rural Economy, Anatomy and Zoology, Medicine and Surgery, and Application of Science to Industry. Meetings, free to the public, are held Monday afternoons. Ladies must have a card of admission, which is readily obtainable. The proceedings, including papers, demonstrations, etc., are reported in the *Comptes rendus hebdomadaires de l'Académie des Sciences*. The academy also publishes *Mémoires des Savants Etrangers* and mémoires, or articles, written by the members. In 1878, Edison's phonograph, then not fully completed, was presented at one of the meetings. In order to prove good faith, the demonstrator was obliged to submit to having his nose held, to eliminate ventriloquism. Gouraud and Janssen gave the final demonstration on April 22, 1889. An annual meeting, open to the public, is held in December.

Fifty foundations are administered by the Académie des Sciences. Six Montyon prizes provide a total of 44,845 francs for award. The Guzman prize offers 100,000 francs for proved communication with any heavenly body excepting Mars. Scientific thought is still further stimulated by the Caze prizes, each of 10,000 francs, in physiology and physics; the Caze and Jecher prizes of 10,000 francs each, in general and organic chemistry; the Plumey prize of 4,000 francs, in steam navigation; and by a number of prizes in botany, geography, mathematics, exploration, mineralogy and various other subjects. Moreover, the prizes, medals and other honors bestowed by the Institut are not all limited to the French. Many are freely at the disposal of every race and people, within the limits of merit only.

The conditions of award, prize-lists and other information may be obtained by addressing the Secrétaire Perpetuel de l'Académie des Sciences, Secrétariat de l'Institut, 23 Quai de Conti, Paris. Competing manuscripts should be received at this address by December 31 of the year preceding that in which the competition will be judged. Prizes are awarded at periods varying from one to five years. Scientific works competing for award must be written in French and three copies, with a letter, must be filed with the Secrétariat.

The present president of the Académie des Sciences is Monsieur Emile Bertin. The two perpetual secretaries are Messieurs Emile Picard and Alfred Lacroix. Some of the members are Painlevé, Appell, Roux, Deslendres, d'Arsonval, Admiral Fournier, Haller, Richet, Quénu, Widal and Moureu. Marshal Foch and Prince Roland Bonaparte are free members. The late Prince of Monaco was a foreign associate. Other members not American include Sir Edwin Ray Lankester, Pavlov, Cajal, Yersin, Depage, Wright, Bordet and Bruce. How can one select luminaries from such a firmament?

Members of the Académie Française must be

French. Not so with the other academies. A total American membership of about twenty is distributed among the four other academies of the Institut. American foreign associates of the Académie des Sciences are Dickson, Brown, Campbell, Davis, Loeb, Hale, Waddell, Michelson and Walcott.

The Académie de Médecine, 16 rue Bonaparte, succeeded, by a royal decree dated December 20, 1820, the ancient Académie Royale de Chirurgie and the Société Royale de Médecine. Like most other institutions, it is independent. Its eleven sections are those of anatomy and physiology, medical pathology, surgical pathology, therapeutics and natural medical history, operative medicine, pathological anatomy, obstetrics, public hygiene, legal medicine and medical policing (the last three in one section), veterinary medicine, medical physics and chemistry, and pharmacy.

The members are titular (100), free associates (10), national associates (20), foreign associates (20), national correspondents (100) and foreign correspondents (50). The proceedings are published in the weekly *Bulletin de l'Académie de Médecine*. The private library is freely at the disposal of physicians and surgeons, pharmacists and others interested in medical subjects. Recommendations made to the government by committees of the academy are always seriously considered, and frequently adopted, by the public powers. Many of the great sanitary and hygienic reforms of France are due to the labors of responsible committees appointed by the academy. The membership embraces many of the well-known French medical and surgical authorities. Madame Curie, recently elected, is the first and only woman member.

Naturally of kindred interest with the Académie de Médecine is the Institut Pasteur, 25 rue Dutot. The Institut Pasteur is composed of three sections, on microbiology, serotherapy and biological chemistry. The rabies service falls in the first section. The animals required for the serum service are kept at Garches. The laboratories are those of physiology, fermentation, agricultural chemistry, therapeutic chemistry, physical chemistry, biological chemistry and serotherapy. The Institut also possesses laboratories of exotic pathology, protozoology and entomology, situated at 96 rue Falguière. The present director is Dr. Calmette. Among the laboratory chiefs are Bertrand, Levaditi, Mouton, Fernbach, Marie, Besredka and Nicolle.

Foreign students are welcomed. Free theoretical courses in bacteriology are given. For a small, selected class of postgraduate students, practical courses are given in naval and military medicine, public health, and preparation of vaccines, serums, culture media, etc. The free rabies service discharges a service dignified far beyond the measure of human praise. A beautiful isolation hospital, attached to the Institut, lies just across the street. The Institut library, now emerging from its chaotic war period, may be readily consulted by qualified students. Every visitor should see the crypt and tomb of Pasteur. Affiliated Instituts Pasteur are situated at Lille, Algiers, Tangier, Tunis, Brazzaville (Congo region) and at Nha-Trang and Saigon in Indo-China.

The Collège de France was founded by François I. No fees are asked, except for laboratory work, and no diplomas given. About forty professors compose a faculty lecturing on languages, history, literature, etc., and in some twenty-five branches of science. Arrangements to attend lectures or work in the laboratories should be made in September or October with the appropriate lecturers. The address of the Collège de France is Place Marcellin-Berthelot, Paris. Special laboratories are situated at the Parc des Princes, Avenue Victor Hugo, Boulogne-sur-Seine and at Meudon. The Institut d'Hydrologie et de Climatologie, a part of the Collège, possesses laboratories of physics, chemistry, hygiene and hydrology. A group of museums is situated at the Jardin des Plantes, founded in 1636. Many courses are given at the Jardin, among which are those on annelids, mollusks, zoophytes and zoology (birds and mammals). A School of Botany is also conducted at the Jardin and a course in paleontology given at the Museum of Paleontology.

The Institut National Agronomique, 16 rue Claude Bernard, is directed by the Ministry of Agriculture. It possesses various laboratories. It has an experimental farm at Noisy-le-Roy. The Académie d'Agriculture, 18 rue

de Bellechasse, is devoted primarily to the preparation of information utilized in guiding agricultural legislation. Like the Institut Agronomique, it is attached to the Ministry of Agriculture, but has no connection with the Institut Agronomique. It includes nine sections, has seventy-two titular members and various correspondents and associates, offers a number of prizes and publishes the *Comptes rendus des Séances de l'Académie d'Agriculture.* Among noted members have been Buffon, Calonne, the King of Siam, Edward VII and George V of England, Jussieu, Malesherbes, Pasteur, Roux, Turgot and Vicq-d'Azyr. David B. Warden represented America in 1834, L. O. Howard is now a foreign member and George Washington was a foreign associate from 1789 to 1793. In 1793, the Académie d'Agriculture shared the common fate of dissolution by the Convention.

The limits of this paper are approaching. No discussion can be given at present of the observatories, Sorbonne, hospital clinics, the marine laboratories of Cette, Roscoff, Banyuls, etc., the Radium Institute, Oceanographic Institute and Museum, Bureau of Longitudes and many another cultural organization.

Libraries are attached to all the institutions discussed. Many of the Paris libraries are devoted largely to history, art and literature. The Bibliothèque Nationale, at 58 rue de Richelieu, is the most important public library in France. It grants opportunities for research on permission obtained in writing from the Secretariat. This library is of especial interest to all students, since it is the official depositary for all scientific and other works published. Next in importance among general libraries ranks the library of St. Geneviève, close to the Panthéon. It is open daily until 10 P.M. The library of the Faculté de Médecine, at 12 rue de l'Ecole de Médecine, is large and useful, and contains many current journals.

The "Ressources du Travail Intellectuel en France" (see bibliography) constitutes an invaluable summary of French educational institutions, including libraries. Card catalogs as we know them are not generally used in European libraries, partly because valuable works and historical documents, composing much of the material, can not well be placed freely at the disposal of the merely casual reader. It is usually very easy to obtain any books, manuscripts, etc., desired.

Were I the arbiter *elegantiarum scientiæ,* I should suggest undergraduate study for the first two years in Europe, the last two in America, one or two postgraduate years in America, then for a year or two back to Europe, and so on alternately as long as the consequent intellectual labor might be practicable. By this outline I do not mean mere passive travel in ways blazed by others, but the supplementing of one's own fruitful accomplishments with study of the gifts in similar fields bestowed upon humanity by one's peers and fellows.

In closing, I wish to express especial acknowledgment of kindnesses for which I am indebted to Dr. Tuffier, and particularly to M. Henri Dehérain, curator of the Library of the Institut de France, who reviewed the manuscript and made many invaluable suggestions.

THEODORE C. MERRILL
PARIS, 10 BIS RUE HERRAN,
AUGUST, 1922

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RECENT WORK IN PALEOBOTANY

As chairman of the Committee on Paleobotany in the Division of Geology and Geography of the National Research Council, David White has recently submitted a brief preliminary report which should interest some who are not students of paleobotany. This subject which is sometimes thought to come perilously near to "pure science" is seen to have more points of contact than has been casually assumed. Some of these contacts are with business and industry.

A most interesting feature of recent paleobotanical research is the extended application of the microscope to the study of carbonaceous deposits, including carbonized plant fragments. Consequent on the development of this technique, Dr. Reinhardt Thiessen has made special studies not only of the spores in oil shales, but of spores found in bituminous coals. It would appear that some of the coal beds of the Appalachian Paleozoic are characterized, and may be identified, by some of the types of megaspores entering into the coal composition. Incidentally, the improved technique developed by Thiessen, by Professor E. C. Jeffrey and Miss T. Stadnichenko, who for a time assisted David White in the Geological Survey, assures great progress in the better understanding of the plant debris and products entering into the composition of coals and oil shales, affecting their initial character, and, subject to metamorphic modification, determining their uses and possibilities. Jeffrey has achieved new successes in making transparent sections of anthracite as well as of high rank bituminous coals, so as to reveal in marvelous detail the structure and present condition of the organic matter. In fact Jeffrey's accomplishments in the histological and morphological demonstration of carbonized plant fragments has opened an essentially new field of the greatest importance in paleobotany. In view of the abundance of carbonized plant debris as compared with the regrettable rarity of petrified material, the ability to study the former successfully marks a greater advance in paleobotany.

The study of fossil diatoms which has been greatly stimulated by the work of Dr. Albert Mann of the Carnegie Institution on the deposits in the Pacific Coast Tertiary, as well as in other areas, is arousing considerable interest. A number of paleontologists have thereby been encouraged to examine some of the Tertiary shales of California under the microscope, with consequent discoveries which may aid materially in revising the stratigraphic classification and also in locating new oil pools in southern California. This means that new investigators are entering upon studies along the lines of research to which Dr. Mann has given a large part of his life.

Much of the study here mentioned lies in the field of what might be called *organic geochemistry* and bears on the general question of the origin and classification of coal and oil shales. Investigation may be stimulated by economic interests but does not depend on these for its justification. But even if both the search for and the classification of coal and oil shale should for the present ignore the microscopic remains of life, it is probably safe to forecast that the laws of origin when properly known will shed light on the distribution just as has been the case with ore deposits.

A considerable increase is observed in the amount of university instruction in paleobotany in the last year or two, notably at Chicago, Michigan and the New York Botanical Garden. In the last named institution Dr. Arthur Hollick occupies a new position carrying the title of paleobotanist and will conduct graduate work in connection with Columbia University.

The report calls attention to certain parts of the field of paleobotany, supposedly fertile and promising, yet remaining almost uncultivated. Little attention has yet been given to the microchemistry of the plant residues, meaning the chemical composition of the different structural particles and plant products found under the microscope in oil shales and coals, with deductions as to the original composition of this debris at time of deposition. Micro-chemistry also gives attention to the effects of regulated heat on the different organic components of the rock, noting their changes and the products generated. It is hoped that experimentation

along these lines will be expanded, for it should contribute much to our knowledge not only of the origin of coals and oil shales, but of petroleum. Such studies have an important bearing, also, on the rôle of these components in the production of artificial petroleums of different types. Similar or analogous studies should be made of peats and richly organic mud deposits now forming. "A pitifully small number are engaged in the study of the paleontology and conditions of origin of peats, and still less interest is taken in the paleontology of the bituminous muds now depositing to form the mother substance of petroleum in a future epoch." No one can guarantee that money given for such researches would be the means of bringing to light new principles of practical value to the oil man, but in the light of past advances in science and industry it would be safer to believe that than the opposite.

It is with peculiar timeliness that Dr. Slosson now reminds us that Bacon, after giving other and more evident reasons for investigation, commends experiments without other provocation or justification than that they have never been tried before. The shock comes when we note the concrete thing he suggests, to illustrate such otherwise purposeless adventures or "experiments of a madman." "But of what I may call close distillation no man has yet made trial. Yet it seems probable that the force of heat, if it can perform its exploits of alteration within the enclosures of the body, where there is neither loss of the body nor yet means of escape, will succeed at last in handcuffing this Proteus of matter and driving it to many transformations." Little did Bacon know what this proposed adventure in *destructive distillation* would some day give to the world in coke and gas and coal-tar products and the cracking process and gasoline and dividends. So much for what Bacon called experiments of *Light*. "And it must ever be kept in mind (as I am continually urging) that experiments of Light are even more to be sought after than experiments of Fruit."

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SCIENTIFIC EVENTS

THE OLD ASHMOLEAN MUSEUM AT OXFORD

R. F. GUNTHER, of Magdalen College, Oxford, writes to the London *Times* under date of November 25, as follows:

What is to be done with the Old Ashmolean?

After the Bodleian, the Ashmolean is more widely known than any other university institution. And justly so, for Elias Ashmole, by bringing the contents of Tradescant's London Museum to Oxford, became the founder of the first public museum of natural history in Great Britain. That the scientific collections of Ashmole might be shown in a manner worthy of them, the university erected what is now known as the Old Ashmolean Building, which included a chemical laboratory. It was opened with great ceremony in 1683. For a hundred and fifty years the specimens were to be seen there, and became historic; but when, in the Victorian period, they were scattered among the new museums, many disappeared, and their seventeenth-century association with the old museum was lost.

The building is a fine one, built in the time, and perhaps under the supervision, of Wren. The well-proportioned rooms designed for a public museum are not now much visited by the public. For a number of years they have been used as offices for a succession of praiseworthy undertakings. Some are now empty, and the tenure of the last of the temporary tenants, the staff of the New English Dictionary, is approaching an end. The question arises, What is to be done with the Old Ashmolean?

One proposal is to fill it with books, and to use it as an adjunct to the Bodleian, which is casting covetous eyes on the Divinity School, the Old Clarendon Building, the Sheldonian Theater, the Convocation House, even on Exeter College, and on all adjacent buildings—without doubt it could fill them all.

But, according to another view, the answer is clear. The Ashmolean Museum was built for the collections of Ashmole and Tradescant. These collections should be restored to their ancient home; and to her great public library and the oldest Botanic Garden in Great Britain, Oxford would add the oldest public museum of this country in its original building. Visitors from overseas would find here one more link with the past.

At the present moment a compact and exceedingly valuable collection of ancient scientific instruments of great rarity, and of greater intrinsic worth than the contents of Tradescant's Ark, is

being offered as a gift to the University by Mr. Lewis Evans, F.S.A. The new museums in Oxford have regretfully declined the offer, owing to lack of space. The upper rooms of the Old Ashmolean are standing empty. Mr. Evans's gift is conditional upon his instruments being properly displayed. Their acquisition, in addition to those instruments which are already in the possession of the colleges, would certainly put Oxford in a preeminent position.

When it is remembered that, in the fourteenth and again in the seventeenth centuries, Oxford was the principal home of British science, and that the Ashmolean was a child of the Scientific Renaissance, and for a century and a half the center of the scientific life of Oxford, there is a greater appropriateness in these Oxford collections of early scientific instruments and specimens going there than anywhere else in the world.

THE NATIONAL OFFICE OF EUGENICS IN BELGIUM

ACCORDING to the *Eugenical News,* there was inaugurated at Bruxelles a Belgian National Office of Eugenics. This occupies one of the small rooms of the Solvay Institute of Sociology, situated in the charming Parc Léopold of that city. The director of the new Eugenics Office is Dr. A. Govaerts, who is assisted by Mr. W. Schraenen, an anthropological assistant to Dr. L. Vervaeck, physician of the prison. It is understood that the Institute Solvay has made an appropriation of 10,000 fr. and that Mr. Armand Solvay will make a personal gift of 7,000 fr. Among those who have been instrumental in the establishment of the office may be mentioned, first of all, Dr. M. F. Boulenger, director of the School of the Feeble-Minded at Waterloo and president of the Société Belge d'Eugénique; M. Berryer, Minister of the Interior and of Hygiene; the surgeon general of the Belgian Army, Willemaerts; Col. Noterman, head of the Army Institute of Physical Military Training; H. Velghe, director general of hygiene in the Department of the Interior; M. Dom, director general of justice; M. Vandervelde, Minister of State; M. Wittemans, senator; M. Gheude, senator of the Province of Brabant; Dr. Bayet, member of the Royal Academy of Medicine; M. Brunet, president of the House of Representatives; Professor Demoor, delegate of the Academy of Medicine; M. Hostelet, director of the Solvay Institute of Sociology. Others who participated in social affairs connected with the congress were Dr. and Mrs. Leclerc-Dandoy, of the University; Professor Ley; Dr. Péchère, Dr. R. Sand and the Rev. Père Fallon. At the meeting of the International Commission in Antwerp the mayor of the city announced that an appropriation had been made for a branch office of the National Office of Eugenics, to be located at Antwerp.

SIR EDWARD SHARPEY SCHAFER, F.R.S.

SOME time ago the suggestion was made that the meeting of the British Association in Edinburgh in 1921 would form a fitting occasion for the presentation to Sir Edward Sharpey Schafer of some token of their esteem from his present and past demonstrators and fellow research workers first in London and afterwards in Edinburgh.

As so many of those who had been trained under him now occupy posts in distant lands it was found impossible to make the necessary arrangements for the presentation at that early date, but Professor Halliburton made a statement at one of the largely attended meetings of the Physiology Section, expressing the desire of all who had been associated with their old master in the prosecution of physiological research to present him with some mark of their esteem and affection, and indicating the form it would probably take. It was appropriate that the announcement should be made in Edinburgh, for Sir Edward Sharpey Schafer has been professor of physiology there since 1899.

It was decided that the presentation should consist of a life-size portrait plaque, and that a medal reproducing the portrait and inscription should be offered to each of the many subscribers. The plaque and the medal are the work of Mr. C. d'O. Pilkington Jackson, A.R.B.A., and the portrait is excellent. The obverse bears in bold relief the bust of Sir Edward Sharpey Schafer and the reverse contains a dedicatory inscription. The plaque itself is of bronze and has been mounted on stone with the inscription shown on the reverse of the medal underneath it. At Sir Edward Sharpey Schafer's desire it will eventually be placed within the University of Edinburgh, but at present it remains in the sculptor's

studio, as he wishes to exhibit it at the Royal Scottish Academy.

The long list of subscribers includes many of the leaders in physiology and other branches of medical science in this and other lands: a few of them may be named—Bayliss, Rose Bradford, Halliburton, L. Hill, MacWilliam, Mott, Starling, in Great Britain; and Hunter and Tait (Canada), Jolly (S. Africa), Malcolm and Mackenzie (New Zealand), Addis and S. Simpson (U. S. A.), Row (India), Itagaki and others (Japan). Among the original subscribers were two of great distinction who have unfortunately passed away—Augustus Waller and Benjamin Moore.

The profession will join in congratulating Sir Edward Sharpey Schafer on this spontaneous tribute from his old pupils and fellow workers to his eminence as a physiologist, and to the inspiration of his teaching, and also in the hope that he still has before him many years of successful work.

THE INTERNATIONAL CONFERENCE ON THE STANDARDIZATION OF SERUMS

DR. AUGUSTUS B. WADSWORTH, director of the division of laboratories and research of the New York State Department of Health, has returned to Albany from Paris, where he represented the Rockefeller Institute on the international committee appointed by the League of Nations to standardize serums for the treatment and prevention of pneumonia, meningitis, diphtheria and other diseases. Dr. Wadsworth makes the following statement in regard to the work of this committee:

The Second International Conference on the Standardization of Serums and Serological Tests of the Health Committee was held under the auspices of the League of Nations, November 20 to 26 inclusive, at the Pasteur Institute in Paris. Professor Theodore Madsen, president of the Health Section of the League of Nations, presided at the conference. Opening addresses were made by Dr. Roux, the discoverer of diphtheria toxin, and the French minister. It is noteworthy that the invitations were extended by the Pasteur Institute and that in the interests of science and humanity the representatives of nine different nations found common ground for this first meeting on French soil. We all shared and enjoyed alike the cordial hospitality of the French scientists.

Immediately after convening the members of the conference were assigned to committees to facilitate the business. Professor Jules Bordet, director of the Pasteur Institute in Brussels, was appointed chairman of the sub-committee on serological tests; Professor Louis Martin of the Pasteur Institute, of the sub-committee on the standardization of tetanus and diphtheria antitoxin; Professor Cantacuzene, of Bucharest, of the sub-committee on antidysentery serum; Professor Neufeld, director of the Robert Koch Institute in Berlin, of the sub-committee on antipneumococcus serum. I was assigned to three of the sub-committees and served as chairman of the sub-committee on the standardization of anti-meningococcus serum.

Progress toward international standardization of serums and serological tests is necessarily a slow one because of the differences in the methods that are used in the several countries, but for this reason the importance and practical value of the work is all the more apparent. Despite the many different points of view, the practical results from the free discussion were most encouraging. If such conferences can be repeated it is not difficult to understand that the ultimate results in improvement of methods used throughout the civilized world will be of the greatest significance for humanity.

SCIENTIFIC NOTES AND NEWS

DR. W. W. CAMPBELL, director of the Lick Observatory, Mount Hamilton, California, on January 4 was unanimously named president of the University of California by the University Board of Regents. He succeeds Dr. Davis Prescott Barrows at the end of the present college semester. The regents agreed to a proposal by Dr. Campbell that he remain as a director of the Lick Observatory as a "dollar a year" man. He will take office on July 1, when Dr. Barrows will become professor of political science.

DR. SAMUEL WESLEY STRATTON, director of the Bureau of Standards, was the guest of honor at a farewell reception at the bureau on December 14. The program included an exhibit of the work of the bureau and a visit to a number of the industrial laboratories. Dr. Stratton was presented with a silver service from the members of the staff.

PROFESSOR G. A. MILLER of the University of Illinois was reelected a member of the council of the American Association for the Advancement of Science at the Boston meeting,

and Professor H. L. Fairchild of the University of Rochester was elected to the council. Dr. J. McKeen Cattell, editor of SCIENCE, and Dr. Henry B. Ward of the University of Illinois were reelected members of the executive committee of the council. Professor Frank Schlesinger, of Yale University, and Professor W. D. Harkins, of the University of Chicago, were chosen members of the committee on grants, which apportions the income of the association to advance scientific research, Professor Schlesinger being chosen to represent astronomy and mathematics, and Professor Harkins to represent chemistry.

PROFESSOR CHARLES E. MENDENHALL, of the University of Wisconsin, has been elected president of the American Physical Society for the year 1923 to succeed Professor Theodore Lyman, of Harvard University.

THE Ecological Society of America at the Boston meeting elected as its president, Dr. C. C. Adams, of the New York State College of Forestry, Syracuse, N. Y.; as vice-president, Dr. G. A. Pearson, of Fort Valley Experiment Station, Flagstaff, Ariz., and as secretary-treasurer, A. O. Weese of James Milliken University, Decatur, Ill.

DR. G. R. LYMAN, of the Bureau of Plant Industry, Washington, has been elected president of the American Phytopathological Society; Dr. F. D. Fromme, of the Virginia Agricultural Experiment Station, vice-president; and Dr. R. J. Haskell of the Department of Agriculture, Washington, secretary-treasurer.

THE Society of Economic Geologists elected at the annual meeting the following officers: J. E. Spurr of New York, *president;* Professor Andrew C. Lawson, of the University of California, *vice-president; directors,* Dr. L. C. Graton, of Harvard University; Dr. Ralph Arnold, of Los Angeles and New York, and Willet G. Miller, of Toronto, Canada.

AT the meeting of the Mineralogical Society of America held at Ann Arbor, Mich., on December 28, 29 and 30, the following officers were elected: For *president,* Dr. Edgar T. Wherry, Bureau of Chemistry, Washington, D. C.; for *vice-president,* Dr. George Frederick Kunz, New York City; for *secretary,* Frank R. Van Horn, Case School of Applied Science, Cleveland, O.; for *treasurer,* Albert B. Peck, University of Michigan, for *editor,* Walter F. Hunt, University of Michigan; for *councilor* 1923-26, Esper S. Larsen, U. S. Geological Survey, Washington, D. C.

THE Perkin medal of the New York Section of the American Chemical Society will be presented to Dr. Milton C. Whitaker, chemical engineer of New York City, at the regular meeting of the section at the Chemists' Club, on the evening of January 12. The following program has been arranged: "Introductory remarks," by Professor Ralph H. McKee; "Impressions," by Dr. A. A. Bachaus; "Whitaker and his Work," by Dr. Arthur D. Little; "Presentation," by Professor Charles F. Chandler; "Acceptance," by Dr. Milton D. Whitaker.

THROUGH an official representative Belgium has dedicated at Stanford University at Palo Alto, Calif., a bronze statue in recognition of the services rendered to that country during the war by Secretary Hoover, who is a graduate of the California institution.

PRINCE GELASIO CAETANI, an engineer by profession, has been appointed Italian Ambassador at Washington. A dinner has been planned in his honor by the American Engineering Council of the Federated American Engineering Societies in Washington on the evening of January 12.

DR. W. HELLPACH, professor of psychology at the Technological School at Karlsruhe, has been appointed *Kulturminister* for the state of Baden.

AT a meeting of the court of the University of Leeds profound regret was expressed at the retirement of Professor Smithells, after thirty-seven years' service as head of the chemistry department, to devote himself to scientific investigation in London.

GENERAL C. G. BRUCE and Colonel E. L. Strutt, of the Mount Everest Expedition, were given an official reception on December 15 in the Sorbonne, Paris, by the French Geographical Society and the French Alpine Club.

DR. N. H. DARTON, of the U. S. Geological Survey, has returned to Washington after nearly two years' field work completing the geologic map of Arizona for the State Bureau of Mines. While Mr. Darton was in Arizona the State University conferred on him the honorary degree of doctor of science in recog-

nition of his work on the geology of the southwest.

DR. CHARLES LANE POOR, professor of celestial mechanics in Columbia University, has been granted leave of absence for the second half-year. In January Dr. Poor will sail for South America, where he will visit Arequipa and other observatories.

DR. E. S. HANDY, ethnologist and Mrs. Willomdean Chatterton Handy, associate in Polynesian folk ways of the Bishop Museum staff, left Honolulu early in January to continue their researches in Polynesian native culture. After a short stay in New Zealand they will proceed to Taluti, where their work for the present year will be centered.

E. A. S. CLARKE, lately president of the Consolidated Steel Corporation, has been elected secretary of the American Iron and Steel Institute.

JOHN MORRIS WEISS, until recently director of development of The Barrett Company, and Charles Raymond Downs, formerly chief chemist of the Barrett Company, and more recently engaged in special plant development work at the Buffalo plant of the National Aniline and Chemical Company, have formed a partnership as consulting chemists and chemical engineers with an office in the Chemists' Building, New York City.

THE seventeenth annual dinner and reunion of the Cornell Society of Engineers will be held at the Fifth Avenue Restaurant, 200 Fifth Avenue, New York, January 19. President Livingston Farrand and Dean Dexter S. Kimball will speak.

DR. BÉLA SCHICK, professor of pediatrics at the University of Vienna, will deliver the fifth Harvey Society Lecture at the New York Academy of Medicine on Saturday evening, January 27. His subject will be "The Prevention of Diphtheria."

THE Mann Juvenile Lectures of the Royal Society of Arts were delivered on January 3 and 10 by Mr. C. R. Darling who spoke on "The Spectrum, its colors, lines and invisible parts, and some of its industrial applications."

THE Swiney lectures on geology, twelve in number, in connection with the British Museum (Natural History), are being delivered at the Royal College of Science, South Kensington, by Professor T. J. Jehu, who has chosen as his subject "Fossils and what they teach."

THE centenary of the birth of Pasteur was celebrated by the Town and Gown Club, Austin, Texas, on the evening of December 21, 1922. The address on "Louis Pasteur, his life and his contributions to science and to humanity" was delivered by Dr. Henry Winston Harper, of the University of Texas.

A STATED meeting of the American Philosophical Society was held on Friday evening, January 5, in Philadelphia to commemorate the centenary of Louis Pasteur. Lawrence J. Henderson, M. D., professor of biological chemistry at Harvard University, delivered an address on "The Life and Services of Louis Pasteur."

A JOINT meeting of the New York Sections of the American Chemical Society and of the Société de Chimie Industrielle was held on January 5 at the Chemists' Club, New York City. A special program was arranged commemorating the centenary of the birth of Louis Pasteur. Speakers were as follows: Professor Gary N. Calkins of Columbia University; "Pasteur and the Science of Fermentation," Professor John M. Nelson of Columbia University; "Pasteur and Chemical Asymmetry." Dr. John W. Churchman of Cornell University Medical School spoke on "The Selective Bacteriostatic Properties of Certain Dyes."

MRS. MABEL HUBBARD BELL, widow of Alexander Graham Bell, died on January 3 at the residence of her daughter, Mrs. David Fairchild at Chevy Chase, Md. Mrs. Bell never recovered from the shock of her husband's death last August. She became completely deaf after an attack of scarlet fever suffered at the age of three years. It was in part through this circumstance that Mr. Bell made the experiments on phonetics that resulted in the invention of the telephone, and it was with the cooperation of Mr. Hubbard, Mrs. Bell's father, that the practical development was carried out. It will also be remembered that Mr. Bell largely occupied himself with work for the relief of the deaf.

At the second assembly of the League of Nations it was decided that cooperation among intellectuels in different countries of the world was a necessary step towards universal peace, and a Commission on Intellectual Cooperation was formed. A meeting of the three sub-committees of this commission, which includes, amongst others, Professor Einstein, Mme. Curie, Professor Bergson, M. Jules Destrée (former Belgian Minister for Science and Arts), and Professor Gilbert Murray, opened in December in Paris. The first sub-committee deals with bibliography, and consists of Professor Bergson, Mme. Curie, and M. Destrée. Amongst others it has coopted Dr. Hagberg Wright (director of the London Library). One of its aims is to institute an international bibliographical bulletin and scientific review. It will also discuss the possibility of forming one or several large international libraries at which all books published in all countries will have to be deposited.

A mission of ten graduates of the engineering schools of Egypt has been sent to America by the Egyptian government to study manufacturing methods in this country. They have been placed in various factories by the Department of Commerce and will work as employees while they are acquiring a knowledge of American methods and machine-shop equipment.

Dr. Carl Skuttsberg, director of the Botanical Garden, Gothenburg, Sweden, and Bishop Museum fellow in Yale University, has completed his field work in Hawaii. Under the guidance of Dr. H. L. Lyon and of other local scientific men, Dr. Skuttsberg made a survey of four islands, with special reference to a comparison of Hawaiian endemic types with those of Juan Fernandez islands and with Alpine flora. The results of his studies will appear among the publications of the Bishop Museum.

The material collected at Palmyra Island and Kingman Reef by a party consisting of Lorrin A. Thurston, David Thanum, Manuel Vasconcellos and Theodore Dranga is said to be of considerable interest to students of the natural history of the Pacific. The primary purpose of the members of the expedition was obtaining sea shells for their private collections, but there were also obtained for the Bishop Museum representative series of crustacea and echinoderms, some land shells and insects, and many species of fish, some of them new to science. A special study was made of the giant Coconut crab, *Birgus latro*.

Dr. S. C. Ball and Professor C. H. Edmondson have submitted to the Bishop Museum a preliminary report of their expedition to Fanning Island, lying about 1,000 miles south of Hawaii. A fairly complete natural history survey of the island and its reefs was carried out. Marine crustacea and echinoderms were found in abundance and a considerable collection of marine molluscs was obtained. The predominant terrestrial animal on all islands of the group is the land crab, *Cardisoma carnifex*, present in hundreds of thousands. One object of the visit was to secure specimens of the two land birds, a paroquet, *Coriphylus kuhli*, and a warbler, *Tartare sp.* The former was found abundant, but the latter less so. Skins and photographs of nine sea and shore birds living on Fanning were also secured. The party brought back 21 species of plants, 50 species of insects, in addition to fishes and lizards. There was little of ethnological interest to be obtained. The expedition was made possible through the courtesy of the Pacific Cable Board, which granted the use of the schooner H. M. S. *Tangaroa* (Captain Menmuir). The staff of the cable station and the officers of the local Copra Company contributed much to the success of the work.

The Forest School of Yale University is the recipient of a valuable table from the Philippine Islands, the gift of the alumni of the school who are employed in the Philippine Forest Service. This table is of Narra wood, 5 feet by 18 feet in size. It was originally presented by the old Spanish Forestry Bureau, known as the Manila Botanical Garden, to the mayor and council of Manila in 1886. After the American occupation the table was used for some time by Governor General William Howard Taft. When Mr. Taft left, it passed into private hands and was recently acquired by the director of the Philippine Forest Service, Arthur F. Fischer, and other Yale alumni. The table is inlaid with an inscription in Camagon wood denoting its origin and disposition. Forty-six kinds of Philippine woods were used to manufacture the table; each sample is numbered and identified for

addition to the school collection, which has for many years been the largest of its kind in the United States. The table will be used in the new forestry building, Sage Hall, the gift of William H. Sage, Yale, '65, which is being erected on Pierson-Sage Square and will be completed during the coming summer.

With a view toward putting temperance work in Japan on a sounder basis through the use of fact rather than opinion or sentiment, a chair of alcohol research is to be established at one of the Japanese universities. To this end Mr. Shyozo Aoki, of Tokyo, a retired merchant of Osaka, has established a foundation known as the Aoki Kyoseikae (Reform Society), granting to it the sum of 100,000 yen ($50,000), to be used in placing in one of the universities of Japan a chair of alcohol research. This decision results from efforts of the American Association for Alcohol Research, founded in 1921 by Captain Richmond P. Hobson, now seeking a similar endowment for a chair of alcohol research in an American university.

A despatch from Toronto to the London *Times* reports that Sir Robert Falconer, president of the University of Toronto, in answer to British criticism, says that "insulin," the recently discovered gland extract for use in the treatment of diabetes, has been patented for one reason only—the protection of the public. It is a means of making certain that the extract will always be of proper strength for effective use. Professor Macleod, for the medical faculty, explains that if the university had not patented "insulin," some commercial company would have done so, and obtained a monopoly. "The holding of the patents has already justified itself in permitting the university to undertake large-scale production so as to work out thoroughly satisfactory methods for the production of uniform potency and minimum toxicity." The university authorities hope that "insulin" will be freely supplied to physicians in general practice early next year.

The Department of Commerce announces that the compilations made by the Bureau of the Census show that 1,032,009 deaths occurred in 1921 within the death registration area of continental United States, representing a death rate of 11.6 per 1,000 population as compared with 13.1 in 1920. The rate for 1921 is the lowest rate recorded in any year since the beginning of the annual compilations in 1900. The death registration area (exclusive of the Territory of Hawaii) in 1921 comprised 34 states, the District of Columbia, and 16 cities in non registration states, with a total estimated population on July 1 of 88,667,662, or 82.2 per cent. of the estimated population of the United States. The death rate from cancer increased from 83.4 per 100,000 in 1920 to 86 in 1921. Some of the other diseases for which the rates increased are diphtheria, typhoid fever, appendicitis, scarlet fever, diabetes and puerperal fever. The fatalities caused by automobile accidents and injuries show an increase from 10.4 per 100,000 in 1920 to 11.5 in 1921. A marked decrease is shown in the death rate from tuberculosis, which was 99.4 in 1921 as compared with 114.2 in 1920; also in the death rate from influenza and pneumonia (all forms) which was 99.8 in 1921 against 208.3 in 1920. The rates for measles, nephritis, bronchitis, whooping cough, heart disease and diarrhea and enteritis also declined.

The first meeting in the interest of applied psychology, held in Berlin recently, was organized by the group for applied psychology, made up of members of the Gesellchaft für experimentelle Psychologie. The correspondent of the *Journal* of the American Medical Association reports that of the many fields of application of psychology, only one was considered at this meeting; namely, industrial or vocational psychology, which, dealing with psychotechnical procedures for establishing experimentally the qualifications of applicants for industrial positions, has awakened, since the war, marked public interest. During the intervals between transactions, opportunity was given to inspect the psychotechnical apparatus of various industrial plants. The first part of the session was devoted to the exhibition of the many psychotechnical methods used in establishing various findings of industrial significance. At the close of the session, a resolution was adopted to the effect that all persons who, in an official capacity, have to do with vocational guidance should accord to psychology the important place it deserves.

The Boston *Transcript* writes: "Colonel E.

Lester Jones, director of the Coast and Geodetic Survey, wanted the modest sum of $40,000 to enable him to complete wire drag work on the North Atlantic seaboard. General Lord, director of the budget, cut the item out of the appropriation bill, and now Representative Shreve, of Pennsylvania, chairman of a subcommittee on appropriations, declares himself incapable of overriding the decision of General Lord. This means that unless the maritime interests can bring sufficient pressure to bear on the committee on appropriations or General Lord or both wire-drag work extending practically from Newburyport along the Maine coast to the Canadian line must be abandoned. The Coast Survey has performed a remarkable service in clearing coastal waters of the boulders which infest them, most of them unknown, and yet many almost directly in the path of coastwise shipping. It will be recalled that a few years ago off Boston harbor one of the great battleships came within something like fifteen feet of striking a hidden rock that might easily have torn her side open and let her go down into one hundred feet of water. A little later it was necessary to wire drag Salem harbor to permit the entrance of another battleship, and twenty-five boulders were removed during the process. The work had proceeded as far as Newburyport harbor, and Colonel Jones estimated that with the new and improved drags he is using $40,000 would enable him to clear the whole American coast. The work must be done eventually, and the appropriation officials may have a hard time explaining why it is being delayed."

UNIVERSITY AND EDUCATIONAL NOTES

The Philadelphia College of Pharmacy and Science is endeavoring to raise $2,000,000 for expansion of its work, and has already raised the sum necessary for a building site, which has been purchased. It is planned to use the $2,000,000 for a group of buildings, with equipment, and in providing an adequate endowment. Rear Admiral W. C. Braisted, formerly surgeon general of the Navy, is the president of the college.

Bates College has received an anonymous gift of $60,000 toward its million-dollar endowment fund. Including the $200,000 conditionally promised by the General Education Board, this brings the fund total to $550,000.

The University of Glasgow has received a gift of £25,500 from Mr. Henry Mechan, of Mechans, Limited, engineers and contractors, Glasgow, for the foundation of a new chair of public health.

On the death, recently, of Mr. Gemmell, brother of the late Dr. Samson Gemmell, regius professor of medicine in the University of Glasgow, the fortune which passed to him on the death of Dr. Gemmell, amounting to approximately £100,000, has been bequeathed to various Glasgow institutions. The sum of £20,000 is left to the trustees of the university for the purpose of endowing a chair in the faculty of medicine or science, to be known as the Samson Gemmell chair. The choice of subject is left to the trustees.

At Clark University Assistant Professor C. E. Melville has been promoted to a full professorship of mathematics.

Dr. A. E. Young, professor of mathematics at Miami University, has resigned to accept position with the Standard Oil Company at Pittsburgh.

Dr. Hugh S. Taylor has been promoted by the trustees of Princeton University to a full professorship in the department of chemistry, with the title of professor of physical chemistry.

W. W. Rubey, assistant geologist of the U. S. Geological Survey, has been granted leave of absence to accept an instructorship at Yale University for the current year.

DISCUSSION AND CORRESPONDENCE

A PROPOSAL FOR WILD PLANT CONSERVATION

The state of Vermont, well noted for rare plants—ferns and flowers—in considerable abundance, recently awoke to the fact that its flora was threatened with extinction. Plants formerly abundant were becoming rare and some rare plants were disappearing from localities where they had been fairly frequent. This applied particularly to various species

of orchids and alpine plants with which Vermont had been rather abundantly supplied.

Investigation pointed to the commercial collectors of live plants as responsible. For such transplantation, it was suggested that the plants would beautify grounds and gardens, and would, perhaps, delight a greater number of people than if they remained in the Vermont woods. Against this, it is to be noted, first, that a high percentage, especially of orchids and alpines, would die in moving. Even arbutus, one of the most difficult wild plants for transplanting, has been offered for sale. A second point lies in the fact that a considerable number of disappearing forms are capable of rather easy and economic artificial propagation. For example, the Goldie Fern and others may be readily grown from spores under cool greenhouse conditions, and the plants so produced are in much better condition for transplanting than specimens pulled up by the roots from the wild. In other words, it is not necessary to deplete the wild supply of such plants in order to supply the market.

In any event, Vermont decided that it wished to keep its own, to maintain its wild flora in approximately its original condition. Under the leadership of the Vermont Botanical Society, a first general game law for plants was drawn up, and in 1921 was passed by the Vermont legislature. This law provides that a specified list of rare plants shall be established as a protected list, and may not be collected for commercial exploitation. Further, botanists are restricted to two specimens per season of the plants named in the list.

The Vermont Law has been made the text of an article in the "American Fern Journal" for September, 1922, in which the action of Vermont is cited as an example worthy of imitation. Other states are also losing large numbers of their rare plants. It is suggested in this article that each state should first study its own situation and then draw up a list of the plants within its borders which seem most in need of protection.

The article further suggests that another type of protection will be necessary in the case of particular species which grow in swamps or other regions threatened by agricultural or industrial development. For example, the climbing fern, common in a few places in Connecticut, and for which the first law protecting plants was passed thirty or forty years ago, is now threatened by the fact that its habitats are desirable places for the cultivation of tobacco. The rare hart's tongue fern, in its best locality in central New York, is threatened by quarrying interests. The only way by which such plants as these can be protected is by the establishment of reservations or sanctuaries of the nature of wild natural gardens.

The "Fern Journal" article, above mentioned, has been reprinted for general distribution throughout the country in the hope that it may reach organizations and individuals in various states who would be interested to start action in their states similar to that taken in Vermont. For this purpose the original article has been somewhat revised and has been reprinted with cover pages, and with additional illustrations of rare plants. Sample copies will be sent to those interested by application to Dr. R. C. Benedict, Brooklyn Botanic Garden, Brooklyn, New York. The type of the reprint has been held for reprinting so that any organization interested may be able to order additional copies at printer's prices. Arrangements have been made to deposit the type plates with Mr. P. L. Ricker, secretary-treasurer of the Washington chapter of the Wild Flower Preservation Society, and future orders will be procurable through him as required.

It may be objected by someone that such a law, without enforcing machinery, is useless and even undesirable, but the fact remains that the original climbing-fern law, to which the same objection might have been raised, was apparently effective in protecting the plant from extinction. Again the necessary community action incident to the study of the situation leading to the proposal of such a law would be highly educative to the people at large, and if a number of states should undertake joint or simultaneous action, the desired result of restricting a mischievous and unnecessary depletion of rare native wild plants would probably be achieved. The Brooklyn Botanic Garden is cooperating with the Fern Society to the extent of ordering and

distributing one thousand copies of the first reprinting of the article.

C. Stuart Gager

THAT CHEMICAL SPELLING MATCH AGAIN

So much has been said and written about this subject since my first note appeared in Science September 29, that I am going to make a further suggestion along the same line.

Requests have come from different universities for details regarding the match, as well as for a list of chemical formulæ which we used in connection with our spelling match. Only one such list could be supplied, however, but if enough interest is aroused in the matter, I shall endeavor to prepare a much larger and more comprehensive list, which might eventually be published in book form.

Much valuable information about a substance is contained in its chemical formula. Therefore, the ability to ascribe the right formula to a given substance, without consulting the literature, is an accomplishment coveted by all chemists.

Formerly competition was the life of trade, but this desirable quality has gradually disappeared as the combining power of the traders developed. Competition, however, remains the motive power in the life of nearly every student, and the chemical spelling match offers one of the best opportunities for spectacular competition in the field of intellectual pursuits.

There is no danger of ever exhausting the supply of formulæ in any chemical spelling match. Even if the "walking encyclopedias" that we hear so much about should get into the contest they would doubtless be spelled down before the hundredth part of the words had been pronounced. Nevertheless, it would be interesting to know who the All-American champion chemical speller is.

Should the subject elicit sufficient interest the country could be divided into twenty-four or more districts and all higher institutions of learning within each district compete for first prize; and then for the semi-final contests the winners in the northwest districts would assemble and spell for the championship of the northwest, and in like manner a champion would be selected from the southwest, one from the southeast, one from the northeast, one from the north central, and one from the south central districts. These six winners in the semifinals should then meet for the national championship battle.

Should the contests prove as interesting and valuable as anticipated, Canada, Great Britain and Australia might want to send representatives to the final matches. Eventually we might even go farther than this. The chemical formula is the same the world over, and there is no reason why chemistry students all over the world should not have an opportunity to compete for so unique an honor.

The general establishment of these contests would stimulate the study of chemistry everywhere, and would therefore mark a long step toward greater efficiency in teaching as well as research. The details of these spelling matches would of course be worked out as the subject develops. It would appear that, in the selection of the winners in both semi-final and final matches, no one should be declared a winner who had not won at least three out of five contests with his opponent.

We have our world's champion boxers, tennis players, scullers, runners, jumpers, vaulters, etc., and would it not be in keeping with the march of events to establish an intellectual event of this sort which combines the elements of sport and usefulness.

Spelling matches could not be supported by the gate receipts, and in order to defray the expenses of the contestants, other means of support would have to be provided. This and numerous other details would be handled by a committee. As chairman of such a committee I know of no one who would be more suitable than Dr. Edwin E. Slosson, of Washington, D. C.

If he would consent to serve in this capacity I should confer upon him this high office, with all the honors, rights and privileges thereunto appertaining.

Make the reward for this championship large enough and contestants will come from all the leading countries of the world. Aye, they would come

From Greenland's icy mountains,
And from India's coral strand;
From Africa's sunny fountains,''
And from Russia's benighted land.

WANTED—A Scientific sport who will establish a prize for the World's Championship in Chemical Spelling.

C. A. Jacobson

Morgantown, W. Va.

A SCIENTIFIC CLEARING HOUSE

A personnel file for American investigators in the biological and physical sciences and their related technologies has been established in Washington, D. C., by the Research Information Service of the National Research Council. This directory of living research workers now lists approximately 14,000 names. A report describing the whole project, with illustrations based upon the personnel records of American psychologists, has just been issued as Bulletin Number 22 of the Council.

When these files were started, some two years or more ago, it was believed that such a record of research workers throughout the country and their scientific activities would, when classified, be widely useful; and experience has shown that through the system installed, facts as to the characteristics, interests and research activities of investigators can be expeditiously assembled.

As now organized the personnel file contains records of investigators in the following major groups of science and technology: (1) Agriculture, (2) Animal biology, (3) Anthropology, (4) Astronomy, (5) Chemistry, (6) Economics and statistics, (7) Education, (8) Engineering, (9) Geology, (10) Geography, (11) Mathematics, (12) Medicine, (13) Plant biology, (14) Physics, (15) Psychology. Several of these groups have been further subdivided as need has arisen. The files of records for economics and statistics and for education remain to be developed, but the data for investigators in other fields are now in useful form.

The original records of these investigators are supplemented by a mechanical punch-card system (Findex). The original file, arranged alphabetically, is consulted for information about any investigator whose name is known; the mechanical file, classified by subject, is consulted for names of investigators having prescribed qualifications. Through this punch-card system it is the matter of but a moment to obtain from any of the major groups a list of people of specified age, experience, achievement, research interest, and so forth. By a single operation selections of names of those meeting any required research specification or combination of specifications can be made.

The usefulness of a comprehensive catalogue mechanically operated for obtaining names of specialists is almost too apparent to need mention. But the personnel file promises to function even more widely and efficiently as a clearing-house for research people who wish to communicate with one another about common or related problems. With a minimum of time and effort the Research Information Service has frequently been able to furnish a half dozen references to current investigations related to that being carried on by some isolated investigator. Such contacts bring mutual advantages and are in accordance with a growing movement to encourage coordination rather than duplication of research. The overlap of activity, too, in the various sciences makes evident the usefulness of such a central clearing-house.

A personnel service specializing in living sources of research information is no less important than a bibliographic service specializing in printed sources. Neither can replace the other but each has its place in helping to furnish a foundation for science and research. Both types of service are rendered by the Research Information Service. Those in need of either kind of assistance are invited to write to Research Information Service, 1701 Massachusetts Avenue, Washington, D. C.

Harold C. Bingham

Assistant Director,
Research Information Service

QUOTATION

VOLUNTARY STUPIDITY

Expressing the conviction that any legislation attempting to limit the teaching of the doctrine of evolution would be a "profound mistake," the American Association for the Advancement of Science, at its opening session on Tuesday, at Cambridge, Mass. (the seat of

Harvard College) went on record as affirming that no scientific generalization is more strongly supported by the thoroughly tested evidence than is that of organic evolution.

A scientific generalization, as we understand it, means a general truth based on the great mass of scientific data that has been compiled since science attained the exactness and definiteness that could make it the basis for reaching conclusions regarding the nature of life.

The men who form the association which has taken this action looking toward a public teaching of the doctrine which has been considered basic in the development of the system of knowledge are the best equipped students and minds in the country. If the lawyer is not to be accepted as authority in his field, if the jury which is called upon to determine cases can not accept the testimony of the experts in various lines which is laid before them in an effort to mete out justice; in a word, if the expert in any line is to be debarred, and his learning and studies discounted, then we have arrived at a point where further progress for the race is impossible. The men who are engaged in America, and the world over, for that matter, in endeavoring to build up a body of knowledge useful for the advancement of the race do not profit greatly by this labor. The fact is, they could do many other things that would bring them greater compensation. This being true, and the fact that life's blood is spent in an endeavor to gain information that will be of welfare to humanity, when considered, should at least make the general public pause and say these men have put forth their greatest efforts in attempting to gain knowledge. It is at least due them that we should weigh and consider what they would have us know.

We hold no brief for the particular doctrine, or as they call it "generalization" of evolution. If people choose to believe that they "sprang from monkeys" that is their affair. The old joke in which the man who voiced this belief was told by his hearer that evidently "he didn't spring very far" was probably as true of the one as the other man in the conversation.

The point lies here. What the best minds of the country believe and would teach, that is the thing which should be promulgated in schools. Those who know less are not the ones who should set themselves up as judges as to what the youth of the country should be taught. Two other things should be kept in mind. One is that the schools to-day are not principally engaged in pouring stuff into the noggin of the pupil. They are busily engaged in teaching him how he can learn things for himself. The other big thing to keep in mind is that beliefs and teachings are more or less a matter of fashion. Ideas and thoughts that are held for a period of years wane and are discredited, then again they come back into fashion and favor.

Only recently in North Carolina we have had a remarkable instance of the absurdity of the fight on evolution. At a state-wide denominational gathering in which one of the leaders in education in the state was expected to be grilled for his utterances on "evolution," he preached such an inspirational sermon as to carry the convention off its feet. The man who had digested the evolutionary theory had still not forgotten his Bible and his God.

So it must be with any body of educators who endeavor to teach the best that is known to the nation's young. Their mind must not be closed to great truths no matter from what source they may come. Their faith must not be so small as to be shaken by the "generalizations" of modern science.

We must still prove all things, and hold fast to that which is good. The way to accomplish that is by learning all that may be learned and not by rejecting all that can be rejected, else will it be said with the truth, that the blind lead the blind.—*The Asheville Advocate.*

DEVELOPED AND POTENTIAL WATER POWER OF THE UNITED STATES

IN 1908 the Bureau of the Census made a special census of the developed water powers of the United States for the report of the National Conservation Commission (Senate Doc. 676, 60th Cong., 2nd session). The data collected were also published by the U. S. Geological Survey in Water-Supply Paper 234, "Papers on the conservation of water resources." This census showed that there were in the United States 31,537 water power plants of all sizes, whose

water-wheel capacity was 5,356,680 horsepower. An examination of the returns indicated that many very small plants were included, as the records showed only 602 plants whose water-wheel capacity was more than 1,000 horsepower. The total capacity of these 602 plants was determined to be 3,900,000 horsepower, leaving 1,457,000 horsepower distributed among 30,935 plants, which thus had an average capacity of only 47 horsepower.

The U. S. Geological Survey, in 1921, made a compilation of data showing the developed water power in the United States in plants of 100 horsepower or more. The data were collected by district engineers of the Survey by correspondence or by personal visits to the plants. Information was furnished by the Census Bureau in regard to the total water power and number of plants in manufactures in the District of Columbia, Kentucky, Indiana, Virginia, Maryland, Delaware and West Virginia. The figures for Maine were furnished by the Maine Water Power Commission. The results of the compilation, which are shown in the accompanying table, are considered to be reliable. The figures given for some of the States, especially Massachusetts, New York, New Jersey, and some of the Southern States may be subject to revision on account of incomplete returns.

The table shows that at present there are in the United States 3,116 water-power plants of 100 horsepower or more, with a total capacity of installed water wheels of 7,852,948 horsepower. Of this total 79 per cent is in public-utility plants and 21 per cent in manufacturing plants. It is of interest to note that the census of 1908, which embraced plants of all sizes, included 10 times as many plants as the present report, which embraces only plants of 100 horsepower or more.

New York still maintains its position as the leading State in the amount of developed water power, with 1,291,857 horsepower; California is a close second, with 1,149,099 horsepower; Washington is third, with 454,356 horsepower; Maine closely follows in fourth place, with 449,614 horsepower, and Montana is fifth with 344,420 horsepower.

To permit a comparison of the developed water power with the total water-power resources a table is included showing the maximum and minimum potential water power of the United States. This table is based on estimates made by the U. S. Geological Survey in 1908 for the National Conservation Commission and revised by the Commissioner of Corporations for his report on water power developed in the United States, 1912, and by the U. S. Forest Service in 1916.

In comparing the figures of developed water power and potential water power for any State or group of States as given in these two tables, the basis for the data in the tables should be kept clearly in mind if gross and absurd errors are to be avoided. The potential water power of the United States was determined by dividing the rivers into sections of different lengths, the length depending on the slope of the channel, and the fall and flow of each section were determined from the best information available. With these factors the potential water power of each stream was determined on the assumption of an efficiency of 75 per cent. in the water wheels. The portions of the streams where the slope is so small that water power can probably never be profitably developed were not included.

The minimum potential water power is based on the average flow of the two seven-day periods of lowest flow in each year of record. This, of course, does not give the absolute minimum flow, but for all practical purposes potential water power based on this flow may be considered as continuous power. The maximum potential water power is based on the flow available for 50 per cent. of the time. The use of storage was not considered in making estimates of either minimum or maximum potential water power. The estimates of both the minimum and maximum potential water power are considered conservative.

It is the general practice in the construction of water-power plants to install hydraulic machinery capable of utilizing stream flow far in excess of the absolute minimum and much in excess of the flow used in determining the minimum potential water power as given in the table. This practice is forcibly brought out by comparing the minimum potential water power with the total capacity of water wheels installed in water-power plants in some of the

New England States. If all the water power of the United States were to be similarly developed, it would probably be necessary to install plants having three or four times the capacity of the estimated minimum potential water power as given in the table. This condition should be fully considered in estimating the amount of potential water power that may still be available in any State at the present time.

SPECIAL ARTICLES

THERMIONIC EFFECTS CAUSED BY ALKALI VAPORS IN VACUUM TUBES

A TUNGSTEN filament was mounted in a vacuum tube in the axis of a cylindrical anode consisting of three parts insulated from one another. In this way, on the guard ring principle, the electron emission from the central portion of the filament could be measured, so that effects due to the cooling by the leads were eliminated. With metallic cæsium in the tube at 25° C. the cæsium vapor forms an adsorbed film consisting of a single layer of atoms completely covering the filament even at filament temperatures of 600° K. or more. The stability of this film appears to be due to the fact that the electron affinity of a tungsten surface (Richardson work function, 4.52 volts) is greater than that of cæsium ions (ionizing potential, 3.90 volts). When a cæsium atom comes close to a tungsten surface, the tungsten thus robs the cæsium atom of its valence electron and leaves it in the form of a univalent positive ion. This ion, however, tends to be held by a strong force to the tungsten surface because of the negative charge induced in the metallic surface by the close proximity of the positive charge of the ion.

The presence of such films is shown experimentally by the very high electron emission and by measurement of the contact potential with respect to a second tungsten filament held at such temperature that the cæsium has evaporated off.

In the presence of minute traces of certain electro-negative gases, adsorbed films of the atoms of these gases are formed on the tungsten, resulting in an increase in the electron affinity of the surface and a corresponding decrease in the normal electron emission (in absence of cæsium). But the tendency of the cæsium to be held by such a surface has thereby been increased, with the result that the cæsium film remains on the surface at an even higher filament temperature. The film then consists of two layers, each of atomic thickness, the first being of electro-negative, the second of electro-positive atoms (ions).

In this way the cæsium film remains intact up to temperatures of about 900° K., and at this temperature (below a visible red heat) emits saturation currents of about 0.3 amperes per square cm. of filament surface. At higher temperatures the cæsium film evaporates off in part and the electron emission falls rapidly. On lowering the temperature the cæsium film reforms and the electron emission returns to its former value. At temperatures below those at which evaporation is appreciable, the saturation current from a cæsium-covered surface is expressed within the probable error of temperature measurement, by Dushman's equation,

$$i = 60.2\ T^2 e^{-b_0/T}\ amps.\ per\ cm.^2$$

where $b_0 = 16000$ degrees. This corresponds to a value of 1.38 volts for the Richardson work function. It is of interest to note that b_0 appears to be practically the same whether the cæsium is adsorbed directly on tungsten or on the adsorbed electro-negative film. The electron emission thus depends primarily on the nature of the atoms forming the actual surface layer and is not materially dependent on the atoms that lie under these.

When a tungsten filament is heated above 1000° K. in cæsium vapor at room temperature, the electron emission falls to negligible values although a large fraction of the surface may still be covered with adsorbed cæsium. This is due to the fact that there is a linear relation between Θ, the fraction of the surface covered by cæsium, and the logarithm of the saturation current. At 800° K. the ratio between the emission from a cæsium film ($\Theta = 1$) and from a pure tungsten surface is about 10^{20}. Thus every change of 0.05 in the value of Θ causes a ten-fold change in the emission. By the time Θ has fallen to 0.7 the emission at 800° or 900° is negligible.

When the cæsium evaporates from the surface film at temperatures in the neighborhood of 1,000° K. it does so in the form of neutral

atoms. Although the electron affinity of a pure tungsten surface is greater than that of the cæsium atom the electron affinity of a surface *partly covered by cæsium* may be less. This does not prevent the cæsium in the surface film being in the form of ions, for the electron affinity that is involved in the formation and stability of these ions in the surface is not that of the surface of the filament but rather that of the pure tungsten layer underlying the cæsium film. As the cæsium ions evaporate from a largely covered surface they take up electrons as soon as they get out of the surface film, for the filament surface, from the position they are then in, has less electron affinity than the ions.

The electron affinity of a surface partly covered with cæsium is a linear function of Θ as follows:

$$\varphi_{\Theta} = \varphi_{w} - \Theta(\varphi_{w} - \varphi_{cs})$$

where φ_{w}, φ_{cs}, are respectively the electron affinities of pure tungsten and a cæsium film, while φ_{Θ} is the electron affinity of the surface when Θ is the fraction of its surface covered by cæsium. Placing $\varphi_{w} = 4.52$ volts; $\varphi_{cs} = 1.38$ volts and making φ_{Θ} equal to the ionizing potential of cæsium (3.90 volts) we find $\Theta = 0.20$. Therefore when 20 per cent. of a tungsten surface is covered by cæsium atoms, the electron affinity of the surface is the same as that of cæsium ions.

Thus when the filament temperature is raised to a point such that Θ is in the neighborhood of 0.2, positive ions begin to escape from the filament without combining with electrons. This result, first found experimentally, occurs at a certain critical temperature in the neighborhood of 1150° K., depending to some extent on the pressure of cæsium vapor and the condition of the filament surface.

The surface of the filament is in one of two states which we may denote by α and β and the transition between these is discontinuous. At a given time part of the filament may be in one state while an adjacent part at the same temperature is in the other state, there being a sharp *boundary* between the two regions which boundary may be made to move along the filament at any desired velocity.

In the α state Θ is more than 0.2, the surface being largely covered by cæsium. The cæsium evaporates in the form of neutral atoms, although as the critical temperature is approached an increasing fraction may leave as positive ions.

In the β state Θ is ordinarily very much less than 0.2 and all cæsium which leaves the surface is in the form of *positive* ions. Since every atom that strikes the surface condenses, the rate of production of positive ions is equal to the rate at which cæsium atoms strike the filament. Thus from the kinetic theory we calculate that the saturation positive current i_{+} is

$$i_{+} = \frac{ep}{\sqrt{2\pi mkT}} = 0.367\frac{p}{\sqrt{T}} \text{amps./cm.}^2$$

where p is the pressure of cæsium vapor in bars, m is the mass of an atom of cæsium, e the charge of an electron, k the Boltzmann constant and T is the absolute temperature of the bulb. The rate of generation of positive ions is thus independent of the filament temperature provided this is above the critical temperature. It is also the same for all filament materials which give the effect. It is proposed that any electrode which *gen*erates positive ions be called a *genode*.

Experiments show that the maximum positive ion currents obtainable from a genode are in fact, above a certain temperature, independent of the genode temperature, are proportional to the vapor pressure in accordance with the above equation, and are the same for tungsten, molybdenum, carbon or nickel.

It is necessary to apply a certain negative voltage to the cylinder to draw off all the ions generated by the genode. Above this voltage the currents appear to be absolutely independent of voltage (much more so than in the case of electron emission). Below this voltage the positive ion current is limited by space charge, the current being proportional to the 3/2 power of the voltage but being smaller than in the case of electron currents between similar electrodes in the ratio of the square roots of the masses of the electron and the cæsium ion (1 : 490).

The measurement of the ion generation affords an apparently extremely accurate method of determining the vapor pressures of alkali metals. For example at a bulb temperature of 24° C. the maximum positive ion current in

cæsium vapor is 32×10^{-6} amps./cm.^{2} from which the vapor pressure is calculated, by the equation given above, to be 0.00166 bar.

The conditions near the critical temperature, where both the α and β surface phases may be present together, are probably analogous to those assumed in van der Waals' theory of the transition between liquid and gas. In the β phase near the critical temperature there is probably an atmosphere, extending out to a distance of several Ångstrom units from the surface of the filament, containing electrons and a slight excess of positive ions. If the temperature is lowered the attractive forces cause a condensation to the α phase which has a much higher concentration of positive ions. At still lower temperatures, the ions probably settle down into a definite monatomic adsorbed film. Under proper conditions the velocity of propagation of the boundary between the two phases has been observed experimentally.

If a thoriated tungsten filament is used in experiments with cæsium vapor it is found that both the electron emission and the ion generation disappear if the filament is first given a heat treatment by which an adsorbed film of thorium is brought to the surface. This result is in full accord with the theory outlined above, for the electron affinity of a fully active thoriated filament is only 2.94 volts. Since this is less than the electron affinity of the cæsium ion we should not expect the cæsium atoms to lose their electrons when they strike the surface. A quantitative study is being made of the phenomena occurring when various proportions of the surface are covered by thorium.

Similar effects to those described in this paper have also been observed with other alkali metal vapors, notably rubidium vapor. The ionizing potentials of these vapors are higher and the vapor pressures lower, so that the effects tend to be less marked. The results, however, confirm the theories which so well explain the behavior of cæsium.

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THE OXIDATION OF SELENIUM BY A NEW GROUP OF AUTOTROPHIC MICRO-ORGANISMS

The discovery of the nitrifying and sulfur-oxidizing bacteria by Winogradsky added much to our knowledge on energy transformation in the metabolism of the living cell. Here were organisms that were able to obtain from the oxidation of purely inorganic substances all the energy necessary for their activities and for the assimilation of the carbon from the carbon dioxide of the atmosphere or from carbonates. The hydrogen, methane and iron bacteria were soon added to these groups of autotrophic microorganisms. However, some of these organisms seem to be able to exist also in the presence of organic matter, from which they can derive their energy, as pointed out by Niklewsky for the methane bacteria, Molish for the iron bacteria and purple sulfur bacteria, Beijerinck and Trautwein for the denitrifying colorless, sulfur oxidizing organisms.

Among the strictly (obligate) autotrophic bacteria, which derive their energy only from the oxidation of the inorganic materials, are the nitrite and nitrate bacteria, as pointed out by Meyerhof, and the sulfur oxidizing organism *Thiobacillus thiooxidans* described recently by the writers, which derives its energy from the oxidation of elementary sulfur, thiosulfates and sulfides.

Another group of organisms can now be added to the list of the autotrophic forms, namely, bacteria which are able to derive their energy from the oxidation of selenium. A small quantity of selenium mixed with fresh soil was slowly oxidized with an increase in soil acidity. When some of this soil was added to a culture medium, consisting of inorganic materials, with elementary selenium as the only source of energy, the medium became cloudy within a few days. There appeared in it a minute, rod shaped bacterium capable of oxidizing selenium to selenic acid. A detailed description of the organism as well as of the methods used in its isolation will be published later.

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